The production of hierarchical hybrid conductive materials that are mesoporous, with pores spanning from sub-micron to microns in size, is important for large-area electrode applications. Here, a simple one-step, low-cost method to fabricate a metal oxide-carbon hybrid materials with a hierarchical pore structure in a microwave oven is demonstrated. Microwave pyrolysis of ferrocene using carbon felt as a microwave absorber, a method that is rapid (tens of seconds), does not require harsh conditions nor costly equipment is utilized, and can be readily scaled up. The produced material has a high specific surface area, a multi-length scale porous structure and a high conductivity, and is quite stable, making it promising for many practical applications. As an electrode in microbial electrosynthesis, the performance is improved by a factor of five and an optimal biofilm of the microorganism is formed on the surface.